STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
UPPER PENINSULA DISTRICT OFFICE

RICK SNYDER
GOVERNOR

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DIRECTOR

January 19, 2018

VIA E-MAIL

Aquila Resources
E 807 Gerue Street
Stephenson, Michigan 49887

Submission Number: 2NN-5PE0-MT3W
County: Menominee
MiWaters Site: 55-Aquila Resources Inc-Back Forty Project
Project Name: Back Forty

Dear Mr. Hildred:

SUBJECT: Request for Clarification & Amplification

The Department of Environmental Quality (DEQ), Water Resources Division (WRD), is reviewing the submitted application materials for impacts to regulated wetlands and streams. To clearly understand the impacts being proposed by the application submission, the WRD is requesting further clarification amplification on the following items:

Steady-State Model and Groundwater Contours

The Wetlands Applications suggests that the water levels used in the wetland impact assessment were, at least in part, based on the water levels determined in the MODFLOW model. On page 7 of the Potential Indirect Wetlands Hydrology Impacts – Back Forty Mine Report included in the Wetlands Application, as revised December 2017, it states that "…Groundwater elevations on Figure 5-5 were determined from the MODFLOW groundwater model…". However, there are discrepancies between the groundwater contour levels and orientations of the contours presented in the Groundwater Modeling Report and the Wetlands Application. MDEQ is requesting additional clarification on the apparent differences in groundwater contours between the figures, MODFLOW output, and the figures and groundwater elevations expressed in the wetlands application.

For example: Figure 5-5 in the Potential Indirect Wetlands Hydrology Impacts (Operations Phase Groundwater Elevations) shows a groundwater high at the eastern edge of the project boundary of approximately 745 to 750 feet while Figure 5-6 of the Groundwater Modeling Report (Projected Groundwater Elevations, Mine Year 7) presents a groundwater high in that same area of 738 feet (225 meters).

Similarly, there is a discrepancy between the groundwater levels contoured in Figure 2-7: Groundwater Elevation Contours in Quaternary and Cambrian Sandstone, May 2012 from the Groundwater Modeling Report and contours on Figure 4-4: Groundwater Monitoring Locations and Groundwater Contours (May 2012) from the Potential Indirect Wetlands Hydrology Impacts

of the Wetland Application (both maps appear to be in NAD 1983 and have a two meter contour interval).

In addition to the elevation differences, there is a difference between the orientations of the groundwater contours between the report figures. The Groundwater Modeling Report states that the contours roughly follow the topography; however, the orientation seems to lay sub-parallel to the Menominee River or in an east-west orientation which is in contrast to the general topography of the project area.

By further example, Figure 2-7 in the Groundwater Modeling Report shows an east-west oriented water level high to the south and east of FMW-7 with a maximum contour of 232 m. Figure 2-7 also appears to include more data points than Figure 4-4 from the Wetland Application. In Figure 4-4, the water level high is centered on FMW-7 (229.68 m) with a high contour value of 228 m for a vertical groundwater difference in this contour area of approximately 3 m. Also Figure 2-7 from the Groundwater Modeling Report, illustrating the May 2012 water levels, shows the water level at wetlands 40/41 at approximately 220 m while the water level for wetlands 40/41 in the Wetlands Application shows a water level of ~223 m. In both cases, the water levels shown based on the Groundwater Modeling Report are ~3 m (9.8 ft) lower than in the Wetland Application figure.

- Please provide a detailed explanation, including any additional controls/data used that explains these discrepancies. Since the Groundwater Modeling Report is being used in the wetland assessment, the figures presented in the Groundwater Modeling Report and those presented in the wetland assessment must use a consistent datum, units, and contour intervals showing all data points used with values posted; all wetland areas should also be identified on all figures to all for comparison.

Figure 4-4 the Modeled Groundwater Elevations in Project Area, Calibrated Model, which is the steady-state model representing initial conditions for the transient models, as DEQ understands it, shows a water level contour high over the project area with a maximum contour level of 225 m at a contour interval of 5 m (16.4 ft). It appears that the target water elevations used in the calibration included at least October 2011 and December 2011 data. However, the calibration period was not clearly identified in the Groundwater Report. Figures 4-1, 4-2, and 4-3 of the Potential Indirect Wetlands Hydrology Impacts report in the Wetlands Application illustrates water levels contours for October 2011, December 2011, and February 2012, respectively all show the highest water level contour in the project area centered around location FMW-5 at just over 228 m. There appears to be a difference between the predicted and measured water levels in this area of at least 3 m (9.8 ft). There are also no sample data/target point locations shown on Figure 4-4 and no outline or identification of the specific wetlands in the site area on the groundwater model figure for direct comparison to other figures in the Wetland Application. It also appears that the head targets used to calibrate the model were at most collected over a period of 1.5 years that only included one growing season.

- Please clarify the calibration period for the steady-state model.
- Provide the contour information shown on Figure 4-4: Modeled Groundwater Elevations in Project Area, Calibrated Model, from the Groundwater Modeling Report, and include the target point locations, the wetland areas outlined, an updated project outline, and adjusted scale as necessary so that it is comparable to the figures provided in the wetlands application.

- Provide a map of the residuals between the calibrated model and the model targets. The map should include the revised site outline, pit area, target locations, target residuals (clearly indicating if + or – from observed), and the site wetland locations.
- Include a table that shows the dates, locations, water level measurements and range of measurements that were used to create the calibrated model.
- Include the mean elevations used to define the targets. Provide significant discussion on the differences between the water levels plotted on the groundwater modeling report figures and the water level contours presented in the wetlands hydrology report. This discussion should be included for all reported water levels in wetlands.
- Clarify and provide detailed explanation on how the projected MODFLOW groundwater model water levels and flux rates were used in the wetland impact assessment and water budget creation. This should include discussion on how the seasonal variations in near-surface hydrology are taken into account as one of the primary drivers of wetland values and functions and how the groundwater model and proposed impacts to wetlands consider seasonal hydrology fluctuations in the hydrology models.
- Provide a table showing the flux values (inflow and outflow) and locations read from the MODFLOW Model that were used as inputs for each wetland assessed in the wetland water budget.
- Explain why the data available for calibration and the averaging of the target values provides adequate calibration of the groundwater model for use in the wetland impact assessment and water budget. Provide additional clarification and detail on why a steady-state model supports the proposed wetland impacts.

The MODFLOW model was refined to include the presence of wetlands to lower the root mean square error (RMSE) and improve the model accuracy. The wetlands were defined using the River Package to better represent the presence of the wetlands in the model. In Section 3-4, page 10 of the Groundwater Modeling Report it states that…" The wetland stage (water level) was set 0.95 m below ground surface and the "bottom elevation" for the wetland boundary conditions was set 4.175x10-4 m below the wetland stage. Hydraulic conductivity was set at 1 m/d."… This means that all of the wetland areas were defined with a water level set at 3.12 ft below the ground surface and the bottom of the wetlands were set at 0.0014 ft below the set water level. The hydraulic conductivity of the "river bottom wetlands" was set at 1 m/day or 3.28 ft/day (compared to the calibrated hydraulic conductivity determined for Layer 1 of 1.5 m/day or 4.92 ft/day).

- Please provide a detailed explanation on how these parameters were determined for the wetlands. Did the presence of the actual soil information (silty, sandy, peat, etc.) go into the parameter selection? Cite any references or include any other information or data that helps support the values assigned.
- Provide a table that shows the surface elevation, water level and estimated bottom of the wetlands based on the soil boring information and compare that to the inputs used for these same wetlands in the project area.

Provide additional clarification how the transient model was setup. This should include the stress periods, how the initial heads were determined and used in the model, and how the drawdown at each year was calculated (what was the reference head file).

- Please provide a table that includes the MODFLOW range in drawdown (in feet) for all wetlands in the project area.

Table 5 – Wetland Piezometer Measured Water Levels

Table 5 in the Response to MDEQ Comments dated October 20, 2017, indicates a vertical separation between ground surface and existing groundwater table. The table states that the Existing Quaternary Groundwater Elevations were derived from piezometer measurements taken in December 2011. The separation between ground and surface water appears to be the difference between the Ground Surface Elevation and the Existing Quaternary Groundwater Elevation. The Wetland Hydrology Report states that no measurements were recorded at piezometer locations in December 2011 and no piezometer data from December 2011 was included with the piezometer records in the Wetland Hydrology Report.

- Provide additional clarification on how the December 2011 measurements derived?
- Include clarification on how groundwater elevations were measured at piezometers where the depth to groundwater exceeded the depth of piezometers?
- How was the Existing Quaternary Groundwater Elevation established? Provide additional detail on the data gathered and information used to establish the December 2011 measurements used on this table.

Upland Wetlands: WL-40/41, WL-14/14a/15b, WL-B1/ B1c

Throughout the wetlands application there is representation of two distinct water tables: the surface water table and the Quaternary water table.

- Please provide any available documentation or evidence that supports a restrictive feature or confining layer between the surface water table and groundwater table in the wetlands described as “upland wetlands”.

Wetland 40/41 (WL 40/41)

The calibrated target used in the groundwater model at FMW-5 is 223.73m (734.0223 feet). The application does not contain the supporting monitoring well elevation data used to establish the target elevation. Figure 2 (from the Response to MDEQ Comments dated October 20, 2017 dated November 2017), Cross-section B-B’ through WL 40/41, projects the groundwater contour at 250 feet offset from FMW-5, showing an elevation 733.1, which was the recorded water elevation in December 2011. The topographical map included on figure 4-5, Wetland Piezometer Locations, of the Potential Indirect Wetland Hydrology Impacts, shows the ground elevation at PZ-22 at approximately 722 feet. The ground elevation recorded with the piezometer instillation reads 733.62 (PZ-22A). Piezometer water table elevation is documented at PZ-22 as 733.9 and PZ-23 as 732.2 feet.

Figure 2 depicts the groundwater elevations at two distinctly different seasons, both represented on the same figure. Additionally, the cross-section establishes a groundwater table that begins with the elevation from FMW-5, which appears to be significantly off-set from the start of the cross-section. Please provide additional clarification on the ground water hydrology in WL 40/41 as follows:

- There appears to be a discrepancy in the vertical datum in excess of 10 feet between the Figures described above. Please provide clarification. All figures and information provided for this application should be represented in a consistent datum and units between the groundwater modeling report, wetland hydrology report and figures, and the piezometer and monitoring well information.

- The application should include the monitoring well elevation measurements recorded during the calibration period and information on how the target heads were produced. Include the calibration period and how many distinct samples were included. Specify the minimum, maximum and average.
- Figures should include water elevations taken from the same sampling period (season and year). Figures should also include a range of seasonal high and low hydrology during the growing season.
- Provide further clarification and detail on how the groundwater elevation was positioned in the cross-section location, outside known monitoring wells. Provide additional clarification if any control points were established to the west, northwest, or north of WL 40/41 to validate the modeled groundwater elevations.
- Provide additional clarification and detail on the determination of the cross-section location, and how the stationing and elevations were determined in relation to FMW-5.
- Figure 2: Cross-section B-B' through Wetland 40/41, shows a dense, low-permeability layer at elevation 729.4. This layer is not represented in the soil boring at piezometer 22 or 23. Please provide evidence or further documentation of a restrictive feature at this location/ elevation that corresponds with this layer or feature on Figure 2.
- Figure 2 shows the location of the Menominee River as ~2,370 feet northwest, but in the figure, it does not state where that point is being measured from? Please clarify.
- Have any pump or slug tests been conducted on this wetland to determine if the wetland water table is separate or not influenced by changes to the Quaternary Groundwater Table?

<u>WL 14/14a/15b</u>

Table 4-1 of the Wetland Hydrology Report states that WL 14/14a/15b has mixed ground and surface water inputs and that the water table sits at the surface to 5-9 meters (16.4 to 22.9 feet) below the soil surface. Figure 3-6, Cross-section A-A', shows a February 2010 water table within approximately 1 meter of the ground surface throughout wetland 14, which is consistent with the piezometer data collected at PZ-1/PZ-1A. Figure 5-56, Cross-section P-P' Through Wetlands 14 and 15b, of the Wetland Hydrology Indirect Impacts Report, shows a measured water table at approximately 1-2 feet below the soil surface. The piezometer measurements in the hydrology report show a measured water table at 705.38 feet. Table 5 from the October 2017 Response to MDEQ Comments shows the Existing Quaternary Groundwater Elevation at 697.5 feet and the ground surface elevation at 716.2 (MSL).

- Figure 4-5 and the corresponding topographic maps on Figures 4-1 through 4-4 show the approximate elevation of PZ-1/PZ1A just within Wetland 14 which extends to the 211-212 meters (692.26-695.54 feet) elevation contours. These figures do not correspond with the elevation information (Table 5) that has been provided for piezometer PZ-1/PZ-1A. There appears to be a discrepancy in the vertical datum in excess of 10 feet between the Figures described above and throughout the wetland application. Please provide clarification. All figures and information provided for this application should be represented in a consistent datum and units between the groundwater modeling report, wetland hydrology report and figures, and the piezometer and monitoring well information.
- The hydrology contours shown on Figures 4-1 through 4-4 show groundwater elevation contours for October 2011, December 2011, February 2012 and May 2012. The groundwater contour in the approximate location of PZ-1/PZ1A ranges between 211 and 212 meters (692.26-695.54 feet) on these figures. Figure 3-6 of the Wetland Hydrology

Report (AA-AA' and BB-BB') shows a cross-section of the groundwater elevation that is consistent with ground surface to water table elevations shown in Figures 4-1 through 4-4; however, these Figures show the water table at approximately 217 meters (711.94 feet) and the soil surface at approximately 218 meters (715.22 feet) in WL-14. Provide additional clarification on the modeled groundwater contours in these figures and how that compares with the modeled groundwater contours in other figures that depict groundwater elevations, specifically figure 5-56 of the Wetland Hydrology Indirect Impacts Report (Cross-section P-P' through WL-14 and 15b), which depicts the existing Quaternary Groundwater Elevation ranging approximately 18-28 feet below the soil surface.

- Figure 5-56 depicts two separate water tables that are expressed as the wetland water elevation and the Quaternary Groundwater Elevation. Please provide evidence or further documentation of a restrictive feature at this location that would result in having two distinct water tables.
- Have any pump or slug tests been conducted on this wetland to determine if the wetland water table is separate or not influenced by changes to the Quaternary Groundwater Table?
- Provide the residual between the measured water elevation and the MODFLOW groundwater model elevation and provide specific discussion on how the residuals were accounted for in WL-14.

Wetland B1/B1c

Figure 4-4 of the Potential Wetland Indirect Hydrology Impact Report shows the location of PZ-10 in WL-B1 at approximately the 220 meter (721.78 feet) contour line. Figures 4-1 through 4-4 (October 2011 through May 2012) show the groundwater elevation measured and contoured at the location of PZ-10 between 221 meters (725.07 feet) and 222 meters (728.35 feet).Table 4-1 of the wetland Hydrology Report states that PZ-10 has a water table that is located 1-3 meters below the soil surface. Table 5 from the Response to MDEQ Comments dated October 2017 states that PZ-10 has a ground surface elevation of 724.2 feet (MSL) and a vertical separation of the Existing Groundwater Table of 14.2 feet. Figure 3-7 from the Wetland Hydrology Report depicts a cross-section through Wetland B1, and shows a ground surface elevation of approximately 221 meters (725.07 feet) and a groundwater elevation of approximately 718 meters (715.22 feet). The piezometer data included with the Wetland Hydrology Report from PZ-10 (November 2010 through May 2012) show a fairly consistent recorded groundwater level of approximately 220.5 meters (723.42 feet).

- There appears to be a discrepancy in the vertical datum in excess of 10 feet between the Figures described above and other Figures within the wetland application. Please provide clarification. All figures and information provided for this application should be represented in a consistent datum and units between the groundwater modeling report, wetland hydrology report and figures, and the piezometer and monitoring well information.
- The measured groundwater contours in Figures 4-1 through 4-4 show groundwater elevations ranging from 221 meters (725.07 feet) to 222 meters (728.35 feet). Figure 3-7 of the Wetland Hydrology Report shows the groundwater elevation at approximately 218 meters (715.22 feet) (February 2010 measurement near FMW-6). Provide additional clarification that accounts for the variations in groundwater elevations.

- The piezometer recordings for PZ-10 show a consistent water level at this location during the measuring period of November 2010 through May 2012 with fluctuations of less than a foot. The piezometer water level averaged 220.5 meters (723.42 feet). Please provide additional clarification and discussion on the ranging values represented on the groundwater contour figures and the consistent values expressed in the piezometer data. Has any additional piezometer data since 2012 been recorded and graphed? If so, does this information continue to trend towards a consistent groundwater level at PZ-10 or does it trend to provide variances or seasonal fluctuations in excess of the piezometer data provided in the Wetland Hydrology Report?
- Figure 5-41 depicts two separate water tables that are expressed as the wetland water elevation and the Quaternary Groundwater Elevation. Please provide evidence or further documentation of a restrictive feature at this location that would result in two distinct water tables.
- Have any pump or slug tests been conducted on this wetland to determine if the wetland water table is separate or not influenced by changes to the Quaternary Groundwater Table?
- Provide the residual between the measured water elevation and the MODFLOW groundwater model elevation and provide specific discussion on how the residuals were accounted for in WL-B1 and B1c.

Additional Hydrology Data Collected Onsite

Please explain if and how any of the hydrology information collected since 2012 has been used to further calibrate or validate the model and the site-wide water balance. Specifically address how the piezometer installation and water table recordings have provided any support to substantiate the groundwater modeling in wetlands. Provide tables and figures, as necessary, to support your narrative.

Direct Wetland Impacts

Draining surface waters from a wetland is a regulated activity. The DEQ has expressed that drainage of groundwater that results in the reduction of wetland hydrology may constitute an impact. As guidance, the DEQ has previously stated that alterations in hydrology of six or more inches should be assessed for impacts to wetlands. The groundwater modeling provided in this wetlands application shows that pit dewatering will impact groundwater elevations and the modeled groundwater contours demonstrate reductions in groundwater elevations that in some wetlands locations impact groundwater in excess of six inches to greater than 5 feet throughout the modeled life of mine. These groundwater elevation reductions are shown to intersect with both “valley-bottom” and “upland” wetlands, as distinguished by this application.

The MDEQ has previously requested further assessment and detail on the impacts to groundwater hydrology that have been modeled to result from pit dewatering. Specifically, in the Correction Request dated January 26, 2017, MDEQ had requested that “significant discussion should be given to areas where it is demonstrated in these [wetlands application] figures that the depth to groundwater will be reduced greater than six inches in wetlands. Further discussion should be given to regulated wetlands that are shown on these figures to experience a reduction in groundwater greater than five feet but have been determined to have “no impact”. Clear and concise detail should be given on how that rationale was made and the determination for the threshold of “impact”.”

The MDEQ has received and reviewed the response provided in the November 7, 2017 application submission, including Figure 5 and 6: Wetland Water Balance Model Hydrographs.

Upon reviewing all application materials submitted to date, it remains unclear why no impacts are being proposed for wetlands where it is shown by the applicant's modeling that groundwater elevations will be drawn down greater than six inches by the resulting cone of depression created by proposed pit dewatering through the modeled life of mine.

After review of the regional groundwater model, wetland watershed models, soil infomration, piezometer and monitoring well water elevation, and supporting infomration provided as part of the application to date, it remains unclear how a determination of perched wetland watersheds was reached for the wetlands being classified as "upland wetlands". The modeled hydrographs show hydrology impacts to these "upland wetland" systems when modeled using the regional groundwater modeling produced by the MODFLOW model in the hydrograph sensitivity analysis. The discrepancies with ground surface elevations and actual measured groundwater elevations compared with modeled elevations and provided figures and maps, as discussed elsewhere in this request for clarification, does not provide a clear conclusion that the wetlands classified as "upland" are indeed perched and not connected to and influenced by alterations and fluctuations in the groundwater system.

- There should be significant discussion given to the impacts assessment in wetland systems where the applicant has stated that the wetland is reliant on interactions with the groundwater system (valley-bottom wetlands). Discussion should be given to groundwater drawdowns modeled through life of mine and clear conclusions should be provided for wetland systems where the modeled drawdown exceeds the MDEQ's recommendation of six inches of hydrology alteration for impact assessment. Specifically address how the groundwater model figures, which represent models that have been provided as part of the application, show reductions in groundwater in wetlands, yet there is no proposed impacts to these wetlands as a result of these modeled groundwater reductions.
- In conjunction with the clarification requested in the above portions of this letter, specifically address how the modeled reductions in groundwater will or will not impact the hydrology of wetland systems. Provide reference of the materials presented in this wetlands application or in the additional clarification and amplification that you are providing to support the rationale behind the impact assessment determination.

<u>Indirect Wetland Impacts</u>

In the Request for Clarification dated October 20, 2017, MDEQ had requested additional clarification on Section 5.5.2: Indirect Hydrologic Impacts Determination of the application. The DEQ specifically requested clarification on the determination of what constitutes an indirect impact to a wetlands.
Section 5.5.2 states that the assessment of hydrologic impacts to wetlands was based upon the following:

1) magnitude of water level drop during operations during the growing season in comparison with pre-development conditions;
2) duration of water level drop during operations during the growing season in comparison with pre-development conditions;
3) seasonality of water level drop during operations during the growing season in comparison with pre-development conditions.

- Please provide additional explanation to further clarify the assessment of impacts. Provide the metrics that were used in determining what magnitude, duration and seasonality thresholds, or combination thereof, establishes a determination of an impact.

Provide additional clarification on what is considered a "seasonality threshold". The level of detail provided should align with the baseline assessment of existing wetland conditions and contain sufficient detail to establish metrics and parameters for wetland monitoring.

- Provide additional clarification on why the specific metrics were chosen and why a certain threshold of these metrics were determined to constitute an impact. Please provide sufficient detail so that the metrics and criteria used in this assessment may be applied and reproduced to reach the same determination of impact.

This section also states that a second assessment of indirect wetland impacts during operation conditions was determined by using a combination of:

1) proximity of wetlands to facility footprint;
2) wetlands that are surrounded on more than one side by the facility footprint;
3) wetland watersheds that will lose a moderate percentage of watershed area due to site operations.

The November 17, 2017 response to the Correction Request states that an "indirect impact is proposed if more than 50% of an existing contributing watershed area becomes occupied by the project during operations".

- Provide additional detail and clarification on how this metric was determined. Include specifics on any literature or studies that were used or referenced when determining this threshold.
- Clarification should include a detailed description of the "50% criteria" described in the Potential Indirect Wetland Hydrology Impacts Report. How was 50% occupation of a wetland watershed determined to constitute an impact?

Thank you for your attention to these items. If you require further details on any of the items addressed in this request, or would like to schedule a conference call to discuss, please contact me at 906-236-0380 or WilsonK17@michigan.gov. Send the requested information to me at DEQ, WRD, Upper Peninsula District Office, 1504 West Washington Street, Marquette, Michigan 49855. Please include your submission number, 2NN-5PE0-MT3W, in your response. The status of your application can be tracked online at https://miwaters.deq.state.mi.us/miwaters/.

Sincerely,

Kristi Wilson
Upper Peninsula District Office
Water Resources Division

cc: VIA ELECTRONIC TRANSMISSION
Andrew Boushey, Aquila Resources
David Anderson, Aquila Resources
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